

Book Review: *The Art of Changing the Brain: Enriching Teaching by Exploring the Biology of Learning*

By James E. Zull PhD; Sterling, Va.: Stylus Publishing, 2002. 263 pages. ISBN #1579220541

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Learning to think of learning as a natural process, rather than a process contrived from received, external knowledge, is the premise for James Zull's book, *The Art of Changing the Brain: Enriching Teaching by Exploring the Biology of Learning*. Zull emphasizes exploring learning from a biological standpoint by creating conditions in the classroom that lead to changing and rewiring the learning process. He uses diagrams to demonstrate the connections between what is known about learning and what is known about the brain. Although he finds no reason to abandon established practices of teaching, he suggests that an understanding of neurobiology may enhance approaches to teaching. Zull's book differs uniquely from other learning theory books in that he maps the brain's structures to the different parts of the learning process.

As a professor of biology and director of a university teaching institute, Zull uses his experience and storytelling ability to help teachers of all levels in understanding the relationship between brain functions and the learning process. Simple examples are used to show how understanding the brain can enhance pedagogical technique. He helps the reader who might struggle with connecting neurobiology to learners by using personal stories to illuminate and amuse. Zull attempts to develop a foundation for learning that involves a cycle beginning with input from the outside world through the senses, proceeding to internal processing and memory, and ending with external action and abstraction. He builds on the traditional learning theories about internal brain processing (e.g., assimilation and accommodation) developed by Vygotsky and Piaget.

Part one of *The Art of Changing the Brain* provides the foundational knowledge about the physical brain. Zull includes the natural relationship between brain structure and learning, brain connections that change data into knowledge, evolution of the brain, motivation of the learner, and use of reason, memory, and emotions. The main ideas consist of the connections between biology, philosophy, and education, including the roles of experience, reflection, abstraction, action, balance, control, danger, pleasure, movement, and feelings by the learner.

Zull says educators should include as many of these ideas as possible to assist with specific plans and efforts in teaching.

Stories from Zull's own classroom experience are used to explain different situations when he felt disconnected from his students. The sample stories helped me understand the fundamental ideas and made it easier to understand the connection between how the physical brain learns and learning theories. One such example was Michelle, who seemed to be getting the information in class by participating and asking many questions, and would write volumes on exams but never quite incorporate the information into her own memory. This illustrates the imbalance between retaining and using the information.

Zull suggests using the biology of the brain and the natural way we learn to enhance teaching policies and practices. We should view our teaching as sensory input and use the knowledge of the sensory brain to guide us in our practice. Through the learner's senses the brain activates the learning cycle.

Education has been historically about authority and control with students waiting for someone else to give them assignments and where knowledge is located outside them: in books, in the teacher's brain, on educational TV, or on the Internet. Zull describes how facts and information processed in this way are about the back integrative cortex of the brain and this is only part of what learning is all about. The other part uses the natural cycle of learning and involves the entire brain. The natural learning cycle described by Zull builds on theories by Piaget, Vygotsky, and Kolb, then takes the theories one step further to include physical brain neuroscience. There should be a balance between receiving knowledge and using knowledge. As a teacher, I want to change data into knowledge by helping the student take ownership of the learning.

Another focus of Zull's learning cycle is on emotion and its influence on motivation, attitude, and behavior in the teacher-learner relationship. This learning cycle illustrates the natural fit between learning and living. Changes in the brain must be built around the reality of motivating learners with what they want and moving away from things that

potentially threaten their happiness and control. Positive emotion makes a difference with learners, helps students feel safe in their learning experience, and promotes the retention of knowledge.

Zull contends the basal (pleasure) and amygdala (fear) structures in the brain may be different by gender, race, culture, or other physical and social factors. What a woman interprets as safe and what a man interprets as safe may be different. As a sub-group of emotions, motivation's effects on learning and the brain seem even trickier to discern. He also discusses how both brain and body chemistry alter memory and how feelings affect reasoning and memory.

The idea that the learning cycle is a natural result of the structure of the brain should encourage us to think about how we might use it to help people learn. He diagrams how each person uses the parts of the brain when learning. The diagram shows a cycle of movement from concrete experiences in the brain to reflective observation, abstract hypothesis, active testing, and back again to concrete experiences. Concrete experience is connected to the premotor and motor sections, reflective observation to the sensory and postsensory areas, abstract hypothesis to the temporal integrative cortex, and active testing to the frontal integrative cortex. Ultimately, the learner must use knowledge rather than memory to accomplish a task.

In the second section of the book, Zull more fully explains the connection between what scientists already know about the brain and how teachers can benefit from the knowledge. He describes the benefits of building on existing knowledge and relates the similarities to existing neuronal networks. Zull makes clear there is no direct connection between the teacher's lesson and the learner's brain without the learner being active in the learning process.

For the teacher to engage the learner in active learning it is important to build on prior knowledge and give concrete examples. Zull says abstract and theoretical ideas have less meaning if no neuronal networks are associated with the concrete experiences of the learner. He cautions us to start the lessons at the learner level and with what the learner brings to the table. Zull describes three things that are known about prior knowledge: (a) prior knowledge is persistent, (b) it is a fact to the learner, and (c) it is the beginning of new knowledge. Additionally, prior knowledge is complex and personal, students are not necessarily aware of all their prior knowledge, and if it is ignored or avoided, it will hinder the teaching. The challenge for teachers is to find where to build on existing neuronal networks.

In the third section, Zull summarizes how to use more of the brain to help people deepen their learning. This is accomplished by the sensory brain collecting the raw data for reflection, abstraction, and action. The tricky part for the learner, according to Zull, is knowing the important parts

for focused concentration. The sensory system, specifically the amygdala, continually screens for possible negative emotional content. The teacher can help in the sensory process by understanding what the student sees and making it a safe environment to explore and learn. This is done by the teacher's producing a rich blend of all the senses with concrete experiences. Sensory input is the connection to the outside world.

Helping people comprehend their experiences is the teacher's task. But the sensory experience is inherently private and cannot be enforced directly. Zull says the integrative process in the learning cycle is what we expect to happen during reflective observation. Bringing the students to the point where they make the information their own requires giving students assignments that encourage use of different parts of the brain. Students need to process and reflect on the information and that takes time. Reflection is needed to develop complexity in knowledge.

Zull suspects that a great deal of the art of changing the brain involves the effective use of written structure. Teachers who convey deeper meaning by their powers of expression have a better chance to reach their students. Playing a part in the development of deep understanding by a learner is the integration of what and where, emotion with fact, big picture with precise detail, symbolic language with prosaic language, and language with image.

The true art for teachers in changing the student's brain is demonstrated when the learner can say they own the knowledge. Zull says this is done when the learner uses the brain to close the learning loop by internalizing the information, attaching it to prior knowledge, and linking the abstract mental notions with new concrete experiences through activity. This natural progression in learning and knowing puts the learner in control. Zull says the art of changing the teacher's brain is in the understanding of the student brain and building from there. "The support given by an effective teacher must allow the student to have some success, no matter how small." ♦

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